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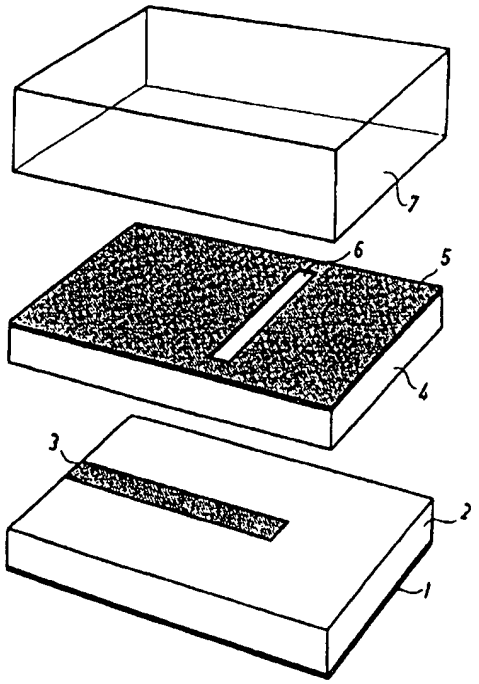
(54) Title: A MICROSTRIP ANTENNA

(57) Abstract

The innovation refers to a microstrip antenna which is made up of several layers, one lying on top of another. Against a first ground plane layer (1) which is made up of a block layer for electro-magnetic radiation lies a first substrate layer (2) and against this a longitudinal feed line (3) which extends in a plane parallel to the first ground plane layer (1). Against the feed line (3) and the first substrate layer (2) lies a further second substrate level (4) and against this a second ground plane layer (5). This is furnished with a slit (6) which extends perpendicular to the length direction of the feed line (3). A third substrate layer (7) lies against the second ground layer (5) which forms the microwave signal coming from the feed line (3) through the slit (6) and the third substrate layer (7).



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A MICROSTRIP ANTENNA

The innovation relates to microstrip antennas which are intended to be used to measure the dielectric constant in a medium, preferably liquids.

An example of such an application is the measurement of fibre content in the stock with paper pulp production. Separate transmitters and receiver antennas can therefore be used whereby the transmitter antenna sends out a microwave signal through the stock and the receiving antenna measures the dielectric constant in the stock. After the received values have been calculated the fibre content in the liquid is obtained which allows for subsequent control during the production process.

Another application is the measurement of oil content in water.

Different kinds of antennas for measuring dielectric constants in liquids are well known today. A simple type of antenna is a single pole (coaxial) antenna. A serious drawback is however that it is difficult to get a large volume of the transmitted energy to reach the receiver antenna in order to get good measuring values.

Another well known type of antenna for measuring dielectric constants in liquids is the so called horn antenna. Such an antenna works well but its mechanical design demands a relatively large space because the transmitted signals pass from air to liquid. The need for space is, in a number of different circumstances, a serious disadvantage, for example measurements made in a liquid which pass through a pipe with relatively small dimensions.

One kind of antenna which has a compact design is the so called patch antenna. This is made up of a ground plane layer which normally consists of a copper plate, a middle layer which is in contact with the ground layer and a microstrip, connected with a so called patch which consists of a copper plate which lies next to the middle layer on a parallel plane with the ground layer. The signals are transmitted from this patch. Such an antenna however, can only be used for measurements in air. The obtained reflection will be large if it is used in liquid. The liquid's dielectric constant cannot be measured with this antenna.

This type of antenna, hereafter called the microstrip antenna, has been developed to transfer radiation energy into a liquid and even to receive this energy without the majority of the energy being reflected. To be precise the patent refers to a microstrip antenna which is designed by putting several different layers on top of each other consisting of a base layer in the form of a first ground plane layer which consists of a block layer for electro-magnetic energy, a first substrate layer lying against this layer and an elongated microstrip feed line lying against the substrate layer and extending in a plane parallel with the first ground plane layer. What distinguishes this microstrip antenna is evident from the attached patent claims.

The innovation will be explained more in detail with reference to the enclosed drawings for which:

Fig. 1 shows an exploded view of a first antenna design according to the patent,

Likewise Fig. 2, shows an exploded view of a second antenna design according to the patent, and

Fig 3 shows the antenna in a composite state according to a third design.

As shown in Fig 1, the microstrip antenna is made up of a first ground plane layer 1 with a rectangular shape. This layer 1 which can be made up of a copper plate constitutes the block layer (stop) for electro-magnetic radiation down along the figure. Attached to this ground plane layer 1 is a first substrate layer 2 with the same rectangular shape and with a defined dielectric constant and thickness. In a plane parallel with the ground plane layer 1, a feed line 3 lies close to the substrate layer 2 and extends from one of the short sides of the substrate layer 2 a length in towards the substrate layer.

According to the innovation the antenna consists moreover of a second substrate layer 4, lying against a feed line 3 and the first substrate layer 2. Substrate layer 4 has the same shape and likewise defined dielectric constant and thickness. Furthermore a second substrate layer 4 lies against a second ground plane layer 5 which likewise can be made up of a copper plate with a slit 6 which extends perpendicular to the length direction of the feed line 3. Finally a third substrate 7 lies against the second ground layer 5 which has the same shape as the two other substrate layers 2, 4. The substrate layer 7 should be of a material which gives small losses within the microwave band when using a penetrating transmitter signal. An example of such a material is quartz or sapphire glass. The substrate layer 7 is adapted to finally shape one microwave signal fed from feed line 3, transmitted through slit 6 and layer 7. Substrate layer 7 can also provide mechanical wear protection against a passing liquid mixture, for example stock.

This embodiment of the innovation is the simplest variation. The antenna is easy to manufacture and gives a broad band signal.

Fig 2 shows a second variation of the innovation. A fourth substrate layer 8 is incorporated in this antenna design which is situated between the second ground plane layer 5 and the third substrate layer 7. The side of this fourth substrate layer 8 which lies against substrate layer 7 is provided with a metal plate 9, a so called patch. The patch is situated in such a way relative to the slit 6 that a longitudinal line through the slit divides the metal plate 8 in two halves.

According to this design the antenna is somewhat more complicated but gives a narrow band signal and has a better gain than the antenna according to the first design description. Further it offers greater matching possibilities to achieve a low reflection.

Fig. 3 shows a third embodiment in a composite state which is an alternative design to the microstrip antenna according to the innovation. The antenna is here made up of the first ground plane layer 1, the first substrate layer 2 with a feed line 3, the fourth substrate layer 8 provided with the metal plate 9 and the third substrate layer 7 which lies against the fourth substrate layer 8 and the metal plate 9. Feed line 3 and the metal plate 9 are according to this design electronically connected with each other via a conductor 10 which extends through the fourth substrate layer 8. A narrow band signal and good gain can be achieved even with this design of antenna.

The microstrip antenna according to the innovation, in all presented and described designs, is made up of a very compact unit which only takes up a small space and therefore can be mounted and used for a number of different applications. The antenna can transfer radiation energy into a liquid and receive same without a large proportion of the energy being reflected. By accurately choosing thickness and dielectric constant of the differ-

ent substrate layers 2, 4, 7 and 8, length and width of slit 6 with the design used in Fig 1 and 2, dimensions of metal plate 9 with the design used in Fig 2 and 3 and, even the point of connection for conductor 10 in the metal plate 9 as laid down in the last description in Fig. 3, optimum values can be achieved. The mechanical design of the microstrip antenna is very simple and at the same time achieves a very good electrical performance.

The innovation is not limited to what has been presented and described and can vary in different ways within the scope of the appended patent claims. Thus the ground plane layer 1 and 5, feed line 3 and plate 9 can be made in other material than copper, such as silver or gold. Of course the antenna can even be designed in another way like that of a parallelepiped.

CLAIMS

1. Microstrip antenna which is built up of several layers, consisting of a base layer in the shape of a first ground plane layer (1) which constitutes a block layer for electro-magnetic radiation, a first substrate layer (2) lying against this layer (1) and an elongated feed line (3) lying against the first substrate layer (2) and extending in a plane parallel with the first ground plane layer (1), characterised in that the antenna is made up of a second substrate layer (4) lying against the feed line (3) and the first substrate layer (2), a second ground plane layer (5), lying against the second substrate layer (4) and provided with a slit (6) which extends perpendicular to the length direction of the feed line (3), and a third substrate layer (7) lying against the second ground layer (5) and forming a micro-wave signal coming from the feed line (3) and passing through the slit (6) and the third substrate layer (7).

2. Microstrip antenna according to claim 1, c h a r a c t e r i s e d in a fourth substrate layer (8) between the second ground plane layer (5) and the third substrate layer (7) which fourth substrate layer (8) on its side which lies against the substrate layer (7) is provided with a metal plate (9), a so called patch, situated relative to the slit (6) such that a longitudinal line through the slit divides the metal plate (9) in two halves.

3. Alternatively design of the microstrip antenna according to claim 1 and 2, c h a r a c t e r i s e d in that the antenna is made up of the first ground layer (1), the first substrate layer (2) provided with the feed line (3), the fourth substrate layer (8) provided with the metal plate (9) and the third substrade layer (7) laying against the fourth substrate layer (8) and the

metal plate (9) and that the feed line (3) and the metal plate (9) are electrically connected with each other via a conductor (10) extending through the fourth substrate layer (8).

4. Microstrip antenna according to anyone of the preceding claims, c h a r a c t e r i s e d in that the third substrate layer (7) is made up of a mechanically hard wearing material with low losses within the microwave band, for example quartz or sapphire glass.

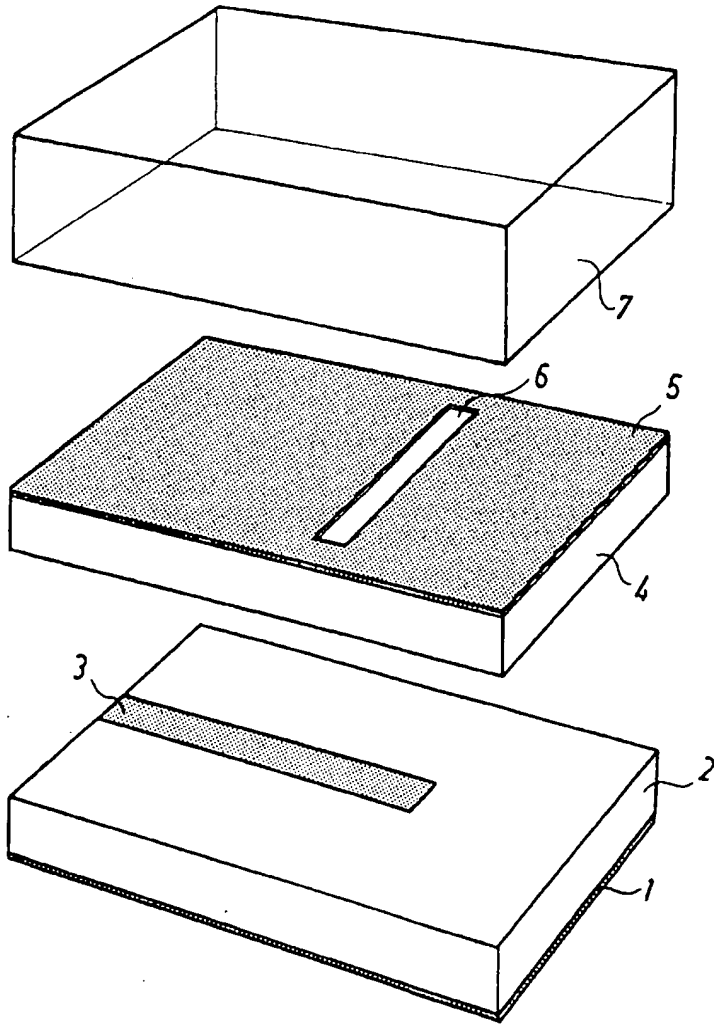

Fig. 1

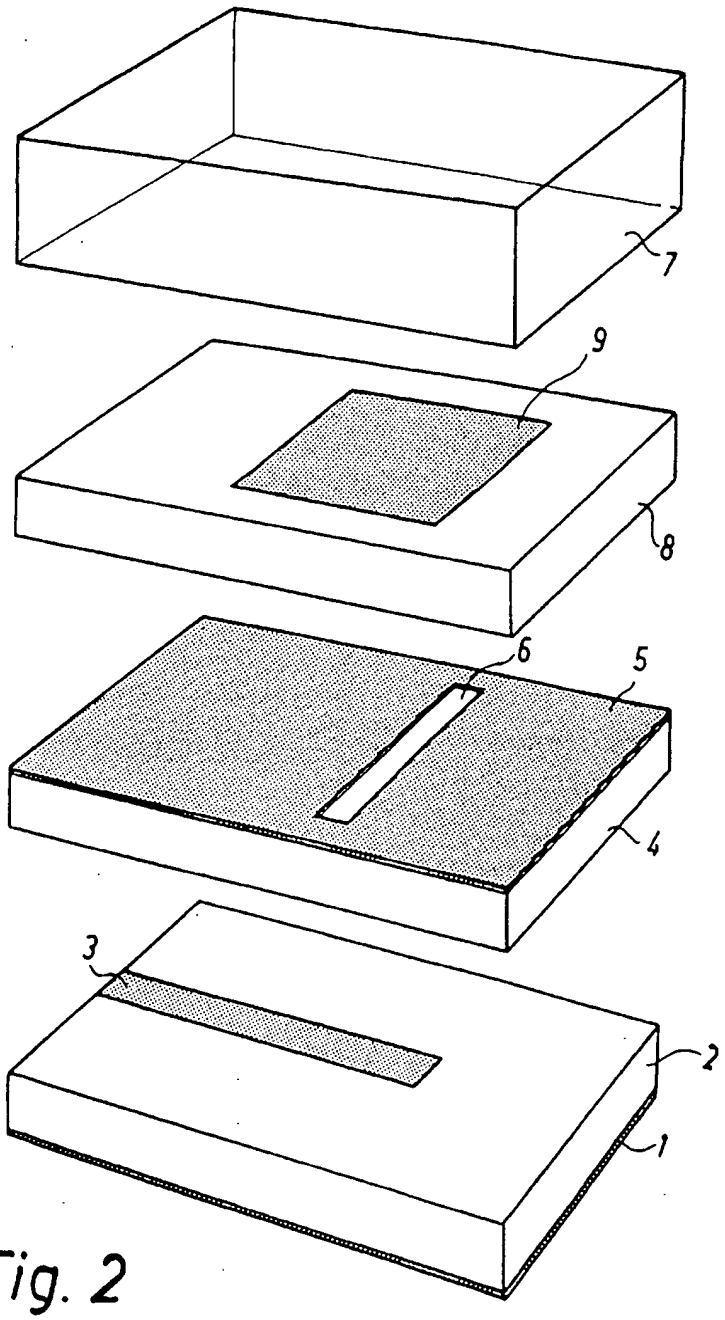

Fig. 2

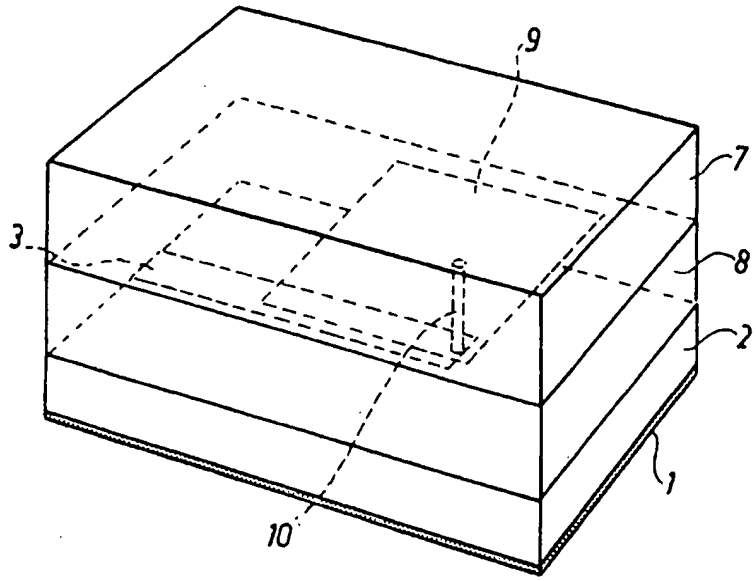

Fig. 3

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 96/01662

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: H01Q 13/10
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

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Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	Patent Abstracts of Japan, Vol 9,No 266, E-352, abstract of JP,A,60-113502 (NIHON MUSEN K.K.), 20 June 1985 (20.06.85) --	1-4
A	Derwent's abstract, No 91-302264/41, week 9141, ABSTRACT OF SU,1626-292A (VINOKUROVA L A), 7 February 1991 (07.02.91) -- --------	1-4

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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